

# VU Research Portal

## A Dutch public-private strategy for innovation in sustainable construction

Bossink, B.A.G.

### **published in**

Construction management and economics  
2002

### **DOI (link to publisher)**

[10.1080/01446190210163534](https://doi.org/10.1080/01446190210163534)

### **document version**

Early version, also known as pre-print

[Link to publication in VU Research Portal](#)

### **citation for published version (APA)**

Bossink, B. A. G. (2002). A Dutch public-private strategy for innovation in sustainable construction. *Construction management and economics*, 20(7), 633-642. <https://doi.org/10.1080/01446190210163534>

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

### **E-mail address:**

[vuresearchportal.ub@vu.nl](mailto:vuresearchportal.ub@vu.nl)

**A Dutch public-private strategy  
For innovation in sustainable  
construction**

**Research Memorandum 2002-37**

Faculteit der Economische  
en Bedrijfskunde (FEWEB)

Universiteit



# **A Dutch public-private strategy For innovation in sustainable construction**

**Research Memorandum 2002-37**

**Bart A.G. Bossink**



**A Dutch public-private strategy for innovation in sustainable construction'**

Bart A.G. Bossink

*Faculty of Economics and Business Administration, Vrije Universiteit Amsterdam,  
The Netherlands*

**Keywords** *Sustainable construction, sustainability policy, innovation management, strategic management*

**Abstract** *Influenced by the sustainable construction policy of the authorities, organizations in the Netherlands are developing, designing and building sustainable areas and objects. The actions of the authorities, authority-related organizations and commercial organizations in the Dutch construction industry and the interaction between them contribute to the realization of goals that fit with the sustainability policy of the government. Research in the house building sector of the Dutch construction industry, covering a 10-year period, has found that action by and interaction between public and private organizations directed towards innovation in sustainable construction is part of a sector-wide strategy. In this strategy public and private organizations interactively develop and adopt sustainable construction innovations.*

<sup>1</sup> Paper is published as an article in the journal Construction Management and Economics: Bossink, B.A.G. (2002) A Dutch public-private strategy for innovation in sustainable construction. *Construction Management and Economics*, 20(7), 633-642.

## 1. Introduction

Sustainable construction has developed from a new field (Kibert, 1994) towards a discipline comprising various practical and scientific issues (Hill and Bowen, 1997; Ofori, 1998; Ngowi, 2001; Rohrer, 2001). Important international issues in sustainable construction affecting the interests of both practitioners and researchers are: environmental assessment of buildings, best practices for sustainable construction, environmental design methods in materials and structural engineering, urban sustainability, and deconstruction (Sjöström and Bakens, 1999). National governments, central and decentralized authorities and commercial organizations in the construction industry are interdependently innovating in these fields of sustainability (Larsson, 1996; Bourdeau, 1999; Rohrer, 2001). One question is how should the public and private parties in the construction industry co-operate to develop sustainable construction innovations? (Larsson, 1996). To seek answers, a research project has been designed and implemented, focussed on a central research question and three sub-questions. The central research question is:

*How do public and private organizations interactively develop sustainable construction innovations?*

The three sub-questions are:

1. What are the elements of a governmental sustainable construction policy?

2. What are the sustainable construction practices of organizations in the construction industry? and
3. **How** do interactions between authorities, authority-related organizations and commercial organizations in the construction industry **contribute** to the realization of goals that fit with the governmental sustainability policy?

## 2. Research Methodology

In this **section** the research design, data collection methods, data analysis method and the implication and limitation of the research findings are described.

### Research design

The research project is typified as multi-method research (Brewer and Hunter, 1989). It consists of a literature study, an interview round and case study research. On the basis of the literature study an overview was made of the elements of the Dutch governmental sustainable construction policy in the period 1989-2000. In the interview round, 62 Dutch experts in the field of sustainable construction were interviewed. Finally, on the basis of the interview round it is possible to present an overview of the sustainable construction practices of organizations in the Dutch construction industry. Case studies were carried out in 6 sustainable construction projects in the house building sector of the Dutch construction industry, leading to a detailed picture of the interactions between authorities, authority-related organizations and commercial organizations in the house building sector, and of the contributions of

these interactions to the realization of goals that fit with the governmental sustainability policy.

**Data collection**

In the literature review publications in the 1990s volumes of many Dutch professional construction journals (*Architectuur & Bouwen, Bouw, Bouwwereld, Bouw/Werk, Cement, Cobouw, Corporatie Magazine, de Bouwadviseur, Land en Water, Woningraad Magazine*) were studied. Also policy documents of the Dutch Government, scientific studies at Dutch universities and newsletters of commercial organizations in the Dutch construction industry covering the 1990s were gathered and analyzed.

The interview round during the period 1994-1999 involved experts working for Dutch public and private organizations, varying from research institutes, provincial and municipal authorities to real estate developers, architects and construction companies (see table 1).

**Table 1** Experts interviewed

Expert	Number of interviews
Manager of a local authority	21
Manager of an architects' firm	12
Manager of a construction company	11
Manager of a building association	4
Manager of a provincial authority	3
Manager of a trade company	3
Manager of a consultants' firm	3
Manager of a real estate developer	2
Manager of a research institute	1
Manager of a knowledge centre	1
Manager of a housing corporation	1

In the case study phase, 6 cases were studied in the period 1993-1999, **all** of housing estate construction in **medium-size** and large municipalities in The Netherlands. In these projects several public and private parties interactively and interdependently developed sustainable housing estates, consisting of **areas** with 100-600 houses, with market **values** varying of 10-50 million Euro. The projects studied were: 'Oikos' in the municipality of Enschede, 'Grootstal' in the municipality of Nijmegen, 'GWL-terrein' in the municipality of Amsterdam, 'Leesten-West' in the municipality of Zutphen, 'Nieuwland' in the municipality of Amersfoort, and 'Rijkerswoerd' in the municipality of Arnhem. The 180 documents studied included agreements, design documents, decision supportive reports, **contracts**, meeting agendas and minutes, project **plans**, evaluation reports and planning schedules.

*Data analysis*

The data were investigated within an analytical framework (Yin, 1999) based on international research findings in the field of sustainable construction. The framework comprises three sub-frames corresponding to the three sub-questions in the research project. The first sub-frame **lists** elements of governmental sustainable construction **policies**, the **second** **lists** sustainable construction **practices** in construction industries, and the third **lists** interactions between authorities, authority-related organizations and commercial organizations in construction **industries**.

*Implication and limitation of the research design*

Theory **building** in sustainable construction is a relatively new discipline and the research project aims to **contribute** to theory development in this field. Because the research design does not aim to **generate** propositions about **interactive** innovation in



sustainable construction in a construction industry, to test them in a representative sample of a population, or to **draw** conclusions for the population, the results are not statistically generalizable to a population in the Netherlands **or** in **any** other country. International research findings in the field of sustainable construction were used to develop an analytical framework, parts of which **may** be used **to** describe and analyze **interactive** sustainability strategies in construction industries in different counties. The description and analysis made within the framework of this study have analytical value for the house **building** sector in The Netherlands but not for other **building** sectors in this country **or** for **building** sectors in **any** other country.

**3. An analytical framework for innovation in sustainable construction**

This **section** presents the analytical framework used to describe and analyze the research data. The framework consists of three sub-frames, and is based on a study of international research findings in the field of sustainable construction: the first lists the elements of governmental sustainable construction **policies**, the **second** lists sustainable construction **practices** used in construction industries and the third lists the interactions of authorities, authority-related organizations and commercial organizations in the construction industry that **contribute to** the realization of goals that fit with the governmental sustainable construction policy (see table 2). The elements **discussed** are those mentioned frequently in the international literature.

Table 2 Analytical framework

<b>Elements of a governmental sustainable construction policy</b> <ul style="list-style-type: none"><li>▸ Environmental policy plans</li><li>▸ Laws and regulations</li><li>▸ Public-private agreements</li><li>▸ Financial incentives and obstacles</li><li>▸ Demonstration projects</li></ul> <b>Sustainable construction practices</b> <ul style="list-style-type: none"><li>▸ Design tools</li><li>▸ Waste management</li><li>▸ Environmental management systems</li></ul> <b>Interactions between public and private organizations in sustainable construction projects</b> <ul style="list-style-type: none"><li>• Communication of ambition and vision</li><li>• Establishment of clear goals and implementation programmes</li><li>• Communication with potential customers</li><li>• Development and establishment of standards</li><li>• Establishment of multi-disciplinary project teams</li><li>• Development of new competences</li><li>• Participation in (inter)national r&amp;d projects</li></ul>
---

*Elements of a governmental sustainable construction policy*

Governments play an important role in the initiation and development of sustainable construction practices, and they develop environmental policy plans to define sustainability goals for several years (Barrett et al., 1999; Raynsford, 1999; Blaauw and Priemus, 2000; Haarman et al., 2000). The environmental policy plans have consequences for the future direction of both public and private organizations. In the plans a government will state what the central, provincial and municipal authorities have to achieve in the field of sustainability and sustainable construction, and also what is expected of private parties in the construction industry (Bon and Hutchinson, 2000; Haarman et al., 2000; Van der Waals and Vermeulen, 2000). Laws and regulations are a second element of a governmental sustainability policy: these are

prescriptive and performance-based. Governments establish codes and levels of performance, and authorities and private organizations have to work within the boundaries of the rules (Bemstein, 1996; Larsson, 1996; Gann *et al.*, 1998; Guy and Kibert, 1998; Bon and Hutchinson, 2000; Ngowi, 2001). Governments also use public-private arrangements to secure a certain level of sustainability in construction practices. In these agreements governments e.g. guarantee a part of the turnover of an entrant in the industry that is producing sustainable materials or is designing and building in a sustainable way. Another example is a government acting as a major client in the development of sustainable construction projects and facilitating, subsidizing and protecting sustainable initiatives (Gann et al., 1998; Raynsford, 1999; Van der Waals and Vermeulen, 2000). Governments also use financial incentives and obstacles to reward environmental friendly initiatives and to hinder activities in other directions. An example of an incentive is the municipal subsidizing of energy efficient heating boilers, and an example of a financial obstacle is the increase of costs for dumping construction and demolition waste (Bemstein, 1996; Raynsford, 1999; Blaauw and Priemus, 2000). A fifth element of governmental sustainable construction policies are demonstration projects that are organized and subsidized by the authorities and authority-related organizations. In these demonstration projects innovative sustainable construction options are tested, developed and prepared for use in sustainable construction projects all over the country (Reijnders and Huijbregts, 2000; Sha et al., 2000).


*Sustainable construction practices*

Organizations in the construction industry work with design tools. These tools enable them to choose and evaluate sustainable materials and sustainable design alternatives

and to **relate** them to financial incentives and obstacles, environmental regulations, and demands of clients (Atkinson et al., 1996; Bourdeau, 1999; **Brandon**, 1999; Boonstra and Knapen, 2000; Papamichael, 2000; Reijnders and Huijbregts, 2000; Rohrer, 2001). Another element of sustainable construction is the management of construction and demolition waste. Separation of waste in several variants, re-use of waste and prevention of waste in the design phase are **all** receiving attention (Apotheker, 1990; Gavilan and **Bernold**, 1994; Bossink and Brouwers, 1996; Ueda and Yamamoto, 1996; Bourdeau, 1999). Another tool frequently used in **practice** is the environmental management system. An organization using an environmental management system integrates the environmental issue in the overall strategy of the organization and in the organizational **processes** and procedures (**Hill** et al., 1996; Ueda and Yamamoto, 1996; Yip, 2000).

#### *Interactions between **public** and private organizations in sustainable construction projects*

In sustainable construction **projects** the vision and the ambitions in the field of sustainability have to be developed and communicated with the participating organizations (Bemstein, 1996; Van der Waals and Vermeulen, 2000). **When** there is a **clear** vision on sustainability and **participants** share the same ambitions, **clear** goals and an implementation plan for sustainability **can** be designed and realized (**Hill** and Bowen, 1997; Van der Waals and Vermeulen, 2000; **Bell** and Lowe, 2001). Investors in sustainable construction **projects** **communicate** with the market to **create** **selling** perspectives. Sustainable built houses appeal to environmentally conscious customers, but **also** appeal to buyers driven by economics, **when** for example the energy savings of the house are substantial (Blaauw and Priemus, 2000; **Moll** et al., 2000; Van Dorst



and Silvester, 2000; Kua and **Lee**, 2002). Standards are being developed that prescribe a minimum sustainable performance **level** in construction projects (Larsson, 1996; Larsson, 1999; Bon **and** Hutchinson, 2000) and sustainable construction projects are being developed by multidisciplinary teams consisting of **specialists** working for different organizations like the authorities, **real** estate developers, **architects**, **consultants**, and contractors (**Hill** and Bowen, 1997; Ngowi, 1998; Van der Waals and Vermeulen, 2000; Rohracher, 2001). Multidisciplinary teams are activated early in the project and are stimulated to brainstorm about their contributions to the sustainable innovation **process** (Rohracher, 2001). The organizations that **participate** in the sustainable construction projects are developing new **areas** of **competence** in the field of sustainability, and this enables them to work on a **higher level** than other organizations, giving them a **competitive** advantage in the market (Rohracher, 2001). The organizations are flexible and are able to integrate new developments in the field of sustainability in their strategy and organizational **processes** (**Hill** and Bowen, 1997; Van der Waals and Venneulen, 2000). Highly innovative organizations are participating in (inter)national r&d projects in which **radical** innovations in the field of sustainability are developed, tested and improved and partners in the network of sustainable innovative organizations are found (Curwell et *al.*, 1999; Glaumann et al., 1999; Kimata, 1999; Larsson and Cole, 2001; Mackley and Milonas, 2001).

#### 4. Sustainable Construction in the Dutch House **Building** Sector

This description of the Dutch policy on sustainable construction and of Dutch sustainable construction **practices** is based on the literature study and the interviews,

while the description of the interactions between public and private organizations that **contribute** to sustainable construction innovation is based on the case studies.

*The Dutch governmental sustainable construction policy*

**Environmental policy plans:** In 1989 the Dutch Government published the first national environmental policy plan by the Ministry of Housing, Town and Country Planning and Environment (MHTCPE, 1989). The plan was based on the strategy for sustainable development of the World Commission on Environment and Development (Brundtland, 1987). In the plan the national environmental policy for the coming four years was described, which is a guideline for the development of **provincial and municipal** environmental policy plans in the **whole** country. Approximately 50% of the actions in the national environmental policy plan apply directly or indirectly to the Dutch construction industry. One year later, in 1990, the Government published a supplementary national environmental policy plan. In this plan the construction industry is mentioned as an industry with high priority (MHTCPE, 1990). In 1993 the Government published the **second** national environmental policy plan. The **second** plan added new goals to the existing **ones** and planned new environmental actions for another four-year period (MHTCPE, 1993). In 1995 the Dutch Government published the **first national action** plan for sustainable construction (MHTCPE, 1995) and in 1997 a **second national action** plan for sustainable construction (MHTCPE, 1997). The plans evaluated the sustainable construction results in the preceding years, set new goals and planned new actions (MHTCPE, 1995; 1997). In 1998 the third national environmental policy plan was published: the two **action** plans for sustainable construction were evaluated and additional environmental goals were set for the

Dutch construction industry (MHTCPE, 1998). In 1999 a third program was published that explicitly **focussed** on the construction industry (MHTCPE, 1999).

*Laws and regulations:* The Dutch Government assures a minimum level of sustainability with laws and regulations, using the Environmental Control Act, the **Building** Construction Act, and the Municipality Act. Within these acts, decrees like the **Building** Materials Decree, the Dumping of Waste Materials Prohibition Decree, the Emissions Decree and the **Building** Decree, and regulations like the **Provincial** Corporate Waste Regulations, the **Municipal** Environmental Regulations, and the **Building** Exterior Criteria Regulations have been developed. The laws, decrees and regulations oblige authorities and organizations in the construction industry to build according to sustainability standards (Roes, 1994; Louwe and Lanting, 1995).

*Public-private agreements:* Within the boundaries of the laws and regulations the central, provincial and municipal authorities develop and sign covenants and declarations of **intent** with organizations in the construction industry. In the covenants the parties **state** their **intent** to **co-operate** in the area of sustainable construction, and the organizations **agree** on an ambition level to strive for (MHTCPE, 1995; 1997; 1999).

*Financial incentives and obstacles:* The government subsidizes environmentally friendly initiatives and solutions in the construction industry, and the central, provincial and municipal authorities develop decrees like the **Building** Subsidies Decree and the Location Subsidies Decree within the existing laws and regulations. These decrees enable the authorities to subsidize sustainable initiatives and solutions



for parties in the construction industry and to hinder **any** initiatives that might bring harm to the environment (Liebregts, 1993; Schuurman et al., 1995; Adriaansens, 1996).

**Demonstration projects:** In **every** medium size and large municipality in The Netherlands demonstration projects have been started, comprising sustainable **building** projects of housing estates with a market value varying from 5 million to 100 million Euro. In the demonstration projects the authorities **co-operate** with market parties. The aim of the demonstration projects is to experiment with new sustainable **technologies**, to develop co-operation routines in the management of sustainable construction projects, to develop the sustainable construction **competence** of the participating organizations, and to demonstrate the new possibilities in the field of sustainable construction (De Vries, 1995; Buijs and Silvester, 1996; Van Hal and Rovers, 1997).

***Dutch sustainable construction practices***

**Design tools:** The development of methodologies for lifecycle analysis of materials, energy and buildings, is **stimulated** by the Dutch government. Most of the methodologies are being developed at universities and at research institutes related to universities (Bijen and Schuurmans, 1994) and used by **consultants'** firms in the construction industry to develop practical lists with environmentally friendly design options (Anink and Mak, 1993; Haas, 1994; Stofberg, 1995; **Stofberg** et al., 1996). Frequently, these lists are used in demonstration projects. In 1996 the Dutch Government initiated the development of a national package with standardized sustainable construction options, developed in co-operation with more than 14



**building** associations, and this has been a standard for most of the construction projects in the country (Jansen, 1996).

**Waste** management: The Dutch Government is developing plans for the control, handling and prevention of construction and demolition waste. Construction and demolition waste is separated according to type and transported to organizations specializing in transforming the waste into materials that may be used either in the construction industry or in other industries (Moors, 1991; Wolters, 1993; Breure et al., 1995).

**Environmental management** systems: The Government wants organizations in the construction industry to work with an environmental management system. Although the government states in its national environmental policy plans that environmental management systems will become obligatory, in the period 1989-2000 the implementation rate of environmental management systems in organizations increased at a slow pace. Organizations that already have a management system for quality assurance and that decide to introduce an environmental management system may integrate the environmental management system into their quality management system (MHTCPE, 1989; Goes, 1994; Louwe and Lanting, 1995).

*Interactions between Dutch public and private organizations in sustainable construction projects*

**Communication of vision and ambition:** A vision and an ambition on sustainability are the essence of starting sustainable house building projects. Organizations meet on a regular basis and discuss the sustainability ambitions of the projects. The

organizations hire consultants who are **specialists** in sustainable affairs, and they in turn coach and advise the project managers in the development of the sustainable vision.

*Establishment of clear goals and implementation programmes:* The sustainability vision may be translated into clear goals using design tools for sustainable materials, energy and buildings. The project managers use methods like planning schemes, milestones, and deliverables and budgets, to ensure that options are integrated in the areas and objects that are developed in the sustainable house building project.

*Communication with and informing of potential customers:* The organizations are aware of the fact that potential customers have to be informed about the special character of the areas and houses they are developing, and consultants are hired to advise and coach the project managers in their communications with market segments. For example information centres are established, information meetings are organized, and advertisements are put in the newspapers. The designs are presented at trade fairs and meetings, and the quality aspects of the sustainable house building projects are promoted.

*Development and establishment of standards:* Consultants introduce and use trademarked design methods and lists. The architects conceptualize the spatial designs and the designs for houses with these methods and lists. At the end of the design stages the authorities evaluate the sustainability of the designs with an evaluation methodology approved by the Dutch Government. In the projects most designs have attained a score of 'innovative' or 'very innovative'.

*Establishment of multi-disciplinary project teams:* Most sustainable house building projects in The Netherlands result from co-operation between provincial authorities, municipal authorities, real estate developers, architects, consultants and contractors. In these projects several disciplines are integrated: e.g. town and country planning, traffic affairs, energy affairs, architecture and construction. Real estate developers and the authorities are the entrepreneurs that develop marketable concepts. They hire architects and consultants to integrate all disciplines in the design stage, and they develop innovative sustainable areas and housing concepts. Then, the contractors are hired to realize these concepts.

*Activation of disciplines in an early stage:* Municipal project managers organize workshops and brainstorm meetings to create a shared innovation vision and ambition. Experts in various disciplines consider the sustainability topic with a view to developing a shared frame of reference. The high level goals are agreed upon at the start of each sustainable house building project, and kept intact during the development, design and realization stages.

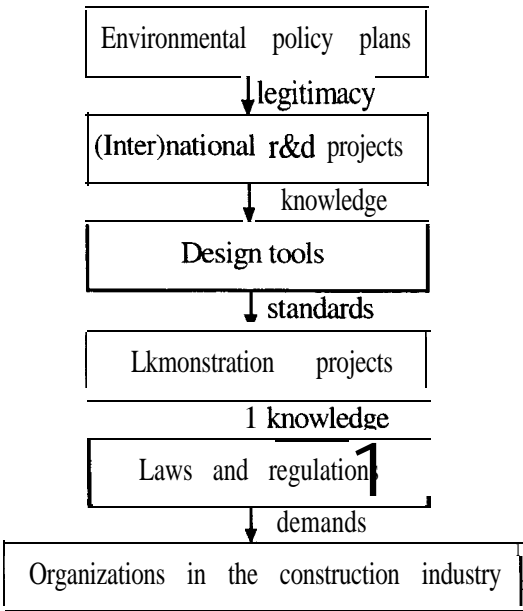
*Development of new areas of competence:* Members of a small network of consultants, architects and contractors participate in almost every sustainable house building project in The Netherlands. These organizations position themselves as green organizations in the market, and promote themselves as capable of developing sustainable areas and high quality projects. Organizations that want to develop competence in sustainable construction participate in sustainable house building projects and learn from these innovation leaders.

*Participation in (inter)national r&d projects:* The network of green organizations consists of knowledge transfer centres established by the Dutch Government, green consultants, green architects, green real estate developers, and green contractors. Frequently, members of the network co-operate in demonstration projects, many of these organizations being related to universities and research centres.

**5. The Dutch public-private strategy for innovation in sustainable house building**

Some elements of the Dutch sustainable house building framework are highly coherent and together constitute a national public-private forum for sustainable construction (see figure 1). The elements of the public-private strategy are: environmental policy plans, (inter)national r&d projects, design tools, demonstration projects, and laws and regulations.

Figure 1 The Dutch public-private strategy for innovation in sustainable house building



Environmental policy plans

The national environmental policy plans describe and set the future direction of the Dutch Government and the construction industry in the field of sustainability. The national environmental policy plans legitimize the initiation and funding of (inter)national r&d projects, in which universities play a dominant role.

### ***(Inter)national r&d projects***

In **r&d** projects the **basic** fundamentals of sustainable construction are researched, and **basic** solutions are developed and further improved. Methodologies for lifecycle analysis are developed and data are generated on the environmental impact of materials and energy.

### ***Design tools***

The knowledge developed in the **r&d** projects is used to develop and improve design tools for the use of materials, energy, buildings and **space**. Methods and lists are developed and used to standardize sustainable construction **practices** in demonstration projects.

### ***Demonstration projects***

In the demonstration projects, **co-operating** innovation leaders in the field of sustainable house **building** experience the do's and don'ts of working with options mentioned in the design methods and lists. This experience is evaluated by the authorities and used to develop laws and regulations.

### ***Laws and regulations***

Sustainable house **building** options that are ecologically and economically sound; are made integral parts of national laws and regulations and become obligatory for **all** organizations in the house **building** sector.

### ***Public-private strategy***

The public-private strategy for sustainable house **building** enables the authorities to continually innovate in the field of sustainability and to integrate innovations in **practice**. Other elements of sustainable house **building** that support this national public-private strategy are: public-private agreements, financial incentives and obstacles, waste management programmes, environmental management systems, vision and ambition building, establishment of clear goals and implementation programmes, communication with potential customers, and development of sustainable **competence**. The authorities use public-private agreements to ensure that organizations in the house **building** sector conform to the new laws and regulations, and financial incentives to stimulate the use of innovative sustainability options in demonstration and other projects. The authorities use waste management programmes to stimulate the separation, handling, **control** and prevention of construction and demolition waste in demonstration and other house **building** projects. They also stimulate the development of environmental management systems to implement green **rules** and procedures in the primary **processes** of organizations in the house **building** sector. The interaction between public and private organizations in the house **building** sector **concentrates** on the development of a sustainable **vision** and ambition, the establishment of clear goals and implementation programmes, communication with potential customers and on the development of sustainable **competence** by the organizations that **participate** in sustainable house **building** projects.

**Factors** that led to failure or stagnation in the sustainable house **building** projects studied were the **absence** of a shared vision and ambition and the **absence** of clear goals and implementation programmes. Due to a lack of **vision** or the **absence** of shared ambitions, organizations **continued** discussing about sustainability instead of

directing their activities towards a shared **vision** and ambition. In addition to this, the **absence** of **clear objectives** and implementation programmes **caused** confusion. **Many** architects and contractors lost track and decided to work with traditional designs, materials and construction methods.

The public-private strategy is used to **create** innovations but is not used to implement them in mainstream house **building** projects in the sector. Knowledge about sustainability is created and developed at universities and research **centres**, and transferred to a **small** network of **consultants** who use it in demonstration projects. In the demonstration projects they work with a limited number of representatives from the **small** network of green authorities, **real** estate developers, architects' **firms** and construction **companies**. These green individuals and organizations develop **competence** in the field of sustainability, but the transfer of knowledge and **competence** in the field of sustainability to other individuals and organizations is not facilitated or stimulated. Mainstream professionals who work for mainstream organizations in the house **building** sector are confronted with laws and regulations that are **extracted** from experience in the demonstration projects, but they do not have the experience, knowledge and **competence** to work within the boundaries of these laws and regulations. The development of experience, knowledge and **competence** to implement the sustainability innovations is not part of a sector-wide public-private strategy. The positive results with the **interactive** approach in sustainability innovation creation support the conclusion that a public-private **interactive** strategy could be used to implement the sustainability innovations in the mainstream **building** projects **all** over the country. This strategy could be an addition to the existing 'laws and regulations approach' of the Dutch authorities.



At the moment the Dutch authorities are developing public-private strategies for sustainable construction in utility building, road construction, and **civil** engineering, and the strategy in the house **building** sector is being used as a blueprint.

## 6. Conclusion

Research in the house **building** sector of the Dutch construction industry, **covering** a **10-year** period, illustrates that **action** of and interaction between **public** and private organizations directed towards innovation in sustainable construction is part of an industry-wide strategy. In this strategy the authorities stimulate and facilitate the development of innovations in the field of sustainability by market parties. The public-private strategy consists of several interrelated elements: environmental policy **plans**, (inter)national **r&d** projects, design **tools**, demonstration projects, and laws and regulations (see Figure 1). The public-private strategy is supported by public-private agreements, financial incentives and obstacles, waste management programmes, environmental management systems, **vision** and ambition building, establishment of clear goals and implementation programmes, communication with potential customers, and the development of sustainable **competence** by organizations in the construction industry. The public-private strategy is directed towards creation of sustainable construction innovations in demonstration projects. The implementation of these innovation in mainstream **building** projects **may** be the subject of an extended public-private strategy in the coming years.

## References

Adriaansens, C.A. (1996) Finance and subsidies in house **building** (Financiering en subsidiëring in de woningbouw). in *Bouwrecht in Kort Bestek*, De Haan, P., Van Voorst van Beest, M.A., Bregman, A.G., and Langendoen, H. (eds). Kluwer: Deventer, pp. 216-219 (in Dutch).

Anink, D. and Mak, J. (1993) *Manual Sustainable House Building (Handleiding Duurzame Woningbouw)*. Steering Group for Experiments in Residential **Building** (SEV): Rotterdam (in Dutch).

Apotheker, S. (1990) Construction and demolition debris – The invisible waste stream. *Resource Recycling*, 9(12), 66-74.

Atkinson, C., Hobbs, S., West, J. and Edwards, S. (1996) Life cycle embodied energy and carbon dioxide emissions in buildings. *Industry and Environment*, 19(2), 29-32.

Barrett, P.S., Sexton, M.G. and Green, L. (1999) Integrated delivery systems for sustainable construction. *Building Research and Information*, 27(6), 397-404.

Bell, M. and Lowe, R. (2001) Building regulation and sustainable housing. part 3: setting and implementing standards. *Structural Survey*, 19(1), 27-37.

Bemstein, H.M. (1996) Bridging the globe: creating an international climate of engineering and construction innovation. *Industry and Environment*, 19(2), 26-28.

Bijen, J.M.J.M. and Schuurmans, A. (1994) *MBB-Project. Environmental Measures in Construction (MBB-Project Milieumaten in de Bouw)*. Milieuberaad Bouw (MBB): Sittard (in Dutch).

Blaauw, K. and Priemus, H. (2000) Obstacles and perspectives for sustainable building. *Milieu; Journal of Environmental Sciences*, 15(2), 111-115.

Bon, R. and Hutchinson, K. (2000) Sustainable construction: some economic challenges. *Building Research and Information*, 28(5-6), 310-314.

Boonstra, C. and Knapen, M. (2000) Knowledge infrastructure for sustainable building in the Netherlands. *Construction Management and Economics*, 18(8), 885-892.

Bossink, B.A.G. and Brouwers, H.J.H. (1996) Construction waste: quantification and source evaluation. *Journal of Construction Engineering and Management*, 122(1), 55-60.

Bourdeau, L. (1999) Sustainable development and the future of construction: a comparison of visions from various countries. *Building Research and Information*, 27(6), 354-366.

Brandon, P.S. (1999) Sustainability in management and organization: the key issues. *Building Research and Information*, 27(6), 390-396.



Breure, B., Kliphuis, O and Veerman, C.P. (1995) *The Construction and Demolition Waste Implementation Program (Implementatieplan Bouw- en Sloopafval)*. Ministry of Housing, Town and Country Planning and Environment: The Hague (in Dutch).

Brewer, J. and Hunter, A. (1989) *Multimethod Research; A Synthesis of Styles*. Sage: Newbury Park.

Brundtland, G.H. (1987) *Our Common Future*. Oxford University Press: Oxford.

Buijs, A. and Silvester, S. (1996) Demonstration projects and sustainable housing. *Building Research and Information*, 24(4), 195-202.

Curwell, S, Yates, A., Howard, N., Bordass, B. and Doggart, J. (1999) The green building challenge in the UK. *Building Research and Information*, 27(4-5), 286-293.

De Vries, G. (1995) Demonstration projects new estates of houses (Voorbeeldprojecten woningen/nieuwbouw), in *Handboek Bouwen en Milieu*, Haas, E.M. and Dicke, D.W. (eds), Weka: Amsterdam (in Dutch).

Gann, D.M., Wang, Y. and Hawkins R. (1998) Do regulations encourage innovation? – The case of energy efficiency in housing. *Building Research and Information*, 26(4), 280-296.

Gavilan, R.M. and Bemold, L.E. (1994) Source evaluation of solid waste in building construction. *Journal of Construction Engineering and Management*, 120(3), 536-555.

Glaumann, M., Malm, T. and Larsson, J. (1999) Evaluation of green buildings in Sweden. *Building Research and Information*, 27(4-5), 276-285.

Goes, R. (1994) Environmental management in construction companies (Milieuzorg in het bouwbedrijf), in *Handboek Bouwen en Milieu*, Haas, E.M. and Dicke, D.W. (eds), Weka: Amsterdam (in Dutch).

Guy, G.B. and Kibert, C.J. (1998) Developing indicators of sustainability: US experience. *Building Research and Information*, 26(1), 39-45.

Haarman, H.R., Van Leeuwen, E.N. and De Haan, M.A.R. (2000) Sustainable building policy in the Netherlands. *Milieu; Journal of Environmental Sciences*, 15(2), 62-70.

Haas, M. (1994) *Environmental Classijication of Building Materials* (Milieuclassificatie Bouwmaterialen). Dutch Insititute for Biological and Ecological Construction (NIBE): Bussum (in Dutch).

Hill, R.C., Bowen, P.A. and Soboil, J.H. (1996) Environmental management systems in the attainment of sustainable construction in South Africa. *UNEP Industry and Environment*, april-june, 13-18.

Hill, R.C. and Bowen, P.A. (1997) Sustainable construction: principles and a framework for attainment. *Construction Management and Economics*, **15**(3), 223-239.

Jansen, P.F.C. (1996) *Sustainable Construction: National Package for House Building* (*Duurzaam Bouwen: Nationaal Pakket Woningbouw*). Foundation for Building Research (SBR): Rotterdam (in Dutch).

Kibert, C.J. (ed.) (1994) *Sustainable Construction; Proceedings of the First International Conference of CIB TG 16*. Center for Construction and Environment (University of Florida): Florida.

Kimata, N. (1999) Japanese expectations for green building assessments. *Building Research and Information*, **27**(4-5), 294-299.

Kua, H.W. and Lee, S.E. (2002) Demonstration intelligent building – A methodology for the promotion of total sustainability in the built environment. *Building and Environment*, **37**(3), 231-240.

Larsson, N. (1996) Public/private strategies for moving towards green building practices. *Industry and Environment*, **19**(2), 23-25.

Larsson, N. (1999) Development of a building performance rating and labelling system in Canada. *Building Research and Information*, **27**(4-5), 332-341.

Larsson, N. and Cole R. (2001) **Green building** challenge: the development of an idea. *Building Research and Information*, 29(5), 77-88.

Liebrechts, M. (1993) **Economic effects** of environmental investments in house **building** (Economische effecten van milieu-investeringen in de woningbouw). in *Ketenbeheer in de Bouw*, Wolters, T.J.J.B. (ed) Samsom: Alphen aan den Rijn, pp. 127-132 (in Dutch).

Louwe, J.B.M. and Lanting, R.W. (1995) *MBB-Project; Environmental Management in Construction (MBB-Project: Aansluitende Milieuzorg in de Bouw)*. Milieuberaad Bouw: Utrecht (in Dutch).

Mackley, C.J. and Milonas, S. (2001) Knowledge transfer and the green **building** challenge. *Building Research and Information*, 29(5), 346-354.

MHTCPE (1989) *The Dutch National Environmental Policy Plan (Nationaal Milieubeleidsplan)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).

MHTCPE (1990) *The Dutch National Environmental Policy Plan + (Nationaal Milieubeleidsplan +)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).



MHTCPE (1993) *The Dutch National Environmental Policy Plan 2 (Nationaal Milieubeleidsplan 2)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).

MHTCPE (1995) *Scheme **of Action** Sustainable Construction (Plan van Aanpak Duurzaam Bouwen)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).

MHTCPE (1997) ***Second** Scheme **of Action** Sustainable Construction (Tweede Plan van Aanpak Duurzaam Bouwen)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).

MHTCPE (1998) *The Dutch National Environmental Policy Plan 3 (Nationaal Milieubeleidsplan 3)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).

MHTCPE (1999) *Policy Programme **Sustainable** Construction (Beleidsprogramma Duurzaam Bouwen)*, Ministry of Housing, Town and Country Planning and Environment, The Hague (in Dutch).

Moll, H.C., Canters, KJ., Glasbergen, P. and De Vries, G. (2000) Sustainable building in the Netherlands. *Milieu; Journal of Environmental Sciences*, **15**(2), 55-61.





Moors, P.G.G. (1991) *Sustainable Construction and Shifts in the Application of Building Materials (Duurzaam Bouwen en Verschuivingen in de Toepassing van Bouwproducten)*. Delftse Universitaire Pers: Delft (in Dutch).

Ngowi, A.B. (1998) Is construction procurement a key to sustainable development. *Building Research and Information*, 26(6), 340-350.

Ngowi, A.B. (2001) Creating competitive advantage by using environment-friendly building processes. *Building and Environment*, 36(3), 291-298.

Ofori, G. (1998) Sustainable construction: principles and a framework for attainment – comment. *Construction Management and Economics*, 16(2), 141-145.

Papamichael, K. (2000) Green building performance prediction/assessment. *Building Research and Information*, 28(5-6), 394-402.

Raynsford, N. (1999) The UK's approach to sustainable development in construction. *Building Research and Information*, 27(6), 419-423.

Reijnders, L. and Huijbregts, M.A.J. (2000) Tools for the environmental evaluation and improvement of buildings. *Milieu; Journal of Environmental Sciences*, 15(2), 89-96.

Roes, H.T.G.M. (1994) *From Bottle Tank to Sunboiler: Important Developments in the Environmental Policy of Municipalities (Van Glasbak tot Zonneboiler: de*



*Belangrijkste Ontwikkelingen binnen het Gemeentelijke Milieubeleid*). Association of Dutch Municipalities (VNG): The Hague (in Dutch).

Rohracher, H. (2001) **Managing** the technological transition to sustainable construction of buildings: a socio-technical perspective. *Technology Analysis & Strategic Management*, 13(1),137-150.

Schuurman, G., Van Twillert, N. and Delamarre, V. (1995) *The Economy of Sustainable Construction* (De **Economie van Duurzaam** Bouwen). Foundation for Building Research (SBR): Rotterdam (in Dutch).

Sha, K., Deng, X. and Cui, C. (2000) Sustainable construction in China: status quo and trends. *Building Research and Information*, 28( 1), 59-66.

Sjöström, C. and Bakens, W. (1999) CIB Agenda 21 for sustainable construction: why, **how** and what. *Building Research and Information*, 27(6), 347-353.

Stofberg, F.E. (1995) *Environmenal Checklist New Estates of Houses* (Milieucheclist *Nieuwbouwwoningen*). Office for Environmental Research and Design (BOOM): Delft (in Dutch).

Stofberg, F.E., Van Hal, A., **Matton**, T. and Kaiser, M.A. (1996) *Building Blocks for a Sustainable City* (Bouwstenen voor **een** Duurzame Stedenbouw). Association of Dutch Municipalities (VNG): The Hague (in Dutch).

Ueda, Y., and Yamamoto, O. (1996) Environmentally sound practices in the construction sector: progress with on-site green techniques (OGTs) in Japan. *Industry and Environment*, 19(2), 40-44.

Van der Waals, J.F.M. and Vermeulen, W.J.V. (2000) Sustainable building: lessons for local policy processes. *Milieu; Journal of Environmental Sciences*, 15(2), 103-110.

Van Dorst, M.J. and Silvester, S. (2000) Sustainable building and sustainable living. *Milieu; Journal of Environmental Sciences*, 15(2), 116-122.

Van Hal, A. and Rovers, R. (1997) *Sustainable Construction . Professional Journal on Sustainable Construction Theme Issue: Demonstration Projects (Duurzaam Bouwen Vakblad over Milieu in het Bouwproces)*, 2(2) (in Dutch).

Wolters, T.J.J.B. (1993) *Chain Management in Construction (Ketenmanagement in de Bouw)*. Samsom: Alphen aan den Rijn (in Dutch).

Yin, R.K. (1999) *Case Study Research: Design and Methods*. Sage: Thousand Oaks.

Yip, J.S.L. (2000) New directions of environmental management in construction: accepted levels of pollution. *Structural Survey*, 18(2), 89-98.